Can we give a version of M.I, which does not involve discussing detectors at all?

Answer is yes, if we can identify the localized states in the theory of the field considered by itself.

Proposal 1 $A(O)\Omega$ is a localized state if $A(O) \in R(O)$.

This does not work at all because:

$I \in R(O)$, so proposal 1. would make $1.\Omega$, i.e. Ω itself a localized state, but none of the 'number eigenstates' are localized!

Proposal 2 (Redhead)

$A(O)\Omega$ is a localized state if $P_{A(O)\Omega} \in R(O)$

We call such an $A(O)$ superlocal.

Theorem 1 (Redhead's Version)

$\text{Prob}(\Omega \to X) \neq 0$

where X is any localized state, i.e. generated from the vacuum by a superlocal operator.

<u>Proof</u> Denote $A(0)\Omega$ by χ where $A(0)$ is superlocal.

Assume $\mathrm{Prob}(\Omega \to \chi) = 0$

$$\Rightarrow \| P_\chi \Omega \|^2 = 0$$

$$\Rightarrow P_\chi \Omega = 0 \qquad *$$

But by Reeh-Schlieder theorem Ω is a <u>separating vector</u> for any local algebra associated with a <u>bounded</u> open set.

Hence, since $P_\chi \in R(0)$

we infer from * that $P_\chi = 0$, but this is impossible since this would imply $\langle P_\chi \rangle_\chi = 0$ instead of one.

So by reductio, the theorem is proved.

Another way of putting this is that superlocal elements of $R(0)$ can never generate states orthogonal to the vacuum, which is another way of saying that the many-particle states are not localized.

<u>Conclusion</u> The detection of particle states in RQFT is not a local operation.

Malament's localized detectors are responding to <u>localized</u> states of excitation of the vacuum, <u>not</u> to particle states.